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PROCEEDINGS OF THE
ROYAL ENTOMOLOGICAL SOCIETY
OF LONDON

SERIES A. GENERAL ENTOMOLOGY

VOLUME 13. 1938.

NOTES ON THE NESTING OF FIVE SPECIES OF SOLITARY WASPS (HYMENOPTERA, SPHECOIDEA)

By PAUL FREEMAN, B.Sc., A.R.C.S., F.R.E.S.

WHILST working at Slough, Bucks., during the summer of 1936 I was able to observe some Sphecoids nesting in the straws of a thatched summer-house. Five species nested there, namely: *Rhopalum clavipes* (L.), *Psenulus atratus* (Fab.), *Trypoxylon figulus* (L.), *T. clavicerum* Lepel. and *T. attenuatum* Smith.

When a wasp was seen going into a straw, the end of the straw was pinched between finger and thumb and the straw pulled out. The adult was kept for reference, measurements of the cells and counts of the prey were made, the prey was preserved in 70% alcohol and eventually identified. A few straws were kept until the larvae were full-grown, and then the larvae were put into separate tubes, and kept until the adults emerged in the spring. By this means it was hoped to get some idea of the arrangement of the sexes in the nests.

Chrysis cyanea (L.) and the Ichneumon *Perithous varius* (Grav.) were occasionally seen flying around the straws, but were not observed to enter any. *Melittobia acasta* (Walker) (Chalcididae) was bred from a nest of *Trypoxylon* sp. (see below).

I should like to thank the following gentlemen for their kind assistance in the identification of the prey and parasites: Mr. J. V. Pearman for the Psocoptera; Dr. A. Randall Jackson for the spiders; Professor E. O. Essig for the APHIDAE; Mr. J. F. Perkins for *Perithous varius*; and Dr. O. W. Richards for *Melittobia acasta*.

I deal with each species separately :—

Rhopalum clavipes (L.).

The prey was Psocoptera, nymphs and adults of six species. The internal diameter of the straws used varied between $2\frac{1}{2}$ mm. and 3 mm., and the nests ended at the first node of the straw. Partitions between the cells were made from the lining of the straw and were very thin. The nests were taken on the 27th and 28th of August, 1936.

The species of prey and total number of each were as follows: *Graphopsocus cruciatus* (L.), 11 females, 2 nymphs; *Peripsocus phaeopterus* (Ste.), 2 females; *Ellipsocus westwoodi* Mclach., 119 females, 7 nymphs; *Mesopsocus immunis* (Ste.), 1 nymph; *Loensia variegata* (Latr.), 1 male; *Hyperetes guestfalicus* Kolb., 1 nymph.

Nest 1. Two cells were complete, and one was unfinished.

Cell 1a. Unfinished; there were 2 nymphs and 6 adult Psocids, and there was no egg.

Cell 1b. Length 10 mm., and the egg was at the inner end. There were

21 adult and 5 nymphal Psocids, but unfortunately the tube containing these and the one containing the contents of cell 2b were broken in the post (see below).

Cell 1c. Length 13 mm., egg on the fifth Psocid from the inner end. Prey 22 females *E. westwoodi*, 2 females *G. cruciatus*, and 1 nymph each of *M. immunis* and *H. guestfalicus*.

Nest 2. Three cells were complete and one was unfinished.

Cell 2a. Unfinished, no egg. Prey, 15 females and 2 nymphs of *E. westwoodi*.

Cell 2b. Egg at the inner end. Prey 21 adults, 4 nymphs. The tube was broken, but 32 damaged specimens were recovered belonging to this cell and to cell 1b. They were 30 females of *E. westwoodi*, 1 female *P. phaeopterus* and a male *L. variegata* (the only male found in all the prey examined).

Cell 2c. This was a curious cell and appeared to be two run into one. There were 58 adult Psocids and5 nymphs with one egg near the inner end. There were also two smaller eggs right at the inner end. I put this cell aside hoping to breed some parasites, but as a normal female *R. clavipes* emerged, the smaller eggs were probably Psocid eggs.

Cell 2d. There was a young larva near the inner end. Prey, 22 females and 1 nymph of *E. westwoodi*, and 2 females of *G. cruciatus*.

Nest 3. Two cells were complete and one was unfinished.

Cell 3a. Unfinished, there was no egg. Prey, 5 females of *E. westwoodi* and 2 females of *G. cruciatus*.

Cell 3b. Length 8 mm., egg attached just behind left hind coxa of one Psocid, length 1·25 mm., breadth 0·3 mm., a little curved, and white. There were only 16 prey, and they were mostly quite lively 24 hours after. Species : 7 females and 2 nymphs of *E. westwoodi*, 4 females and 2 nymphs of *G. cruciatus*, 1 female of *P. phaeopterus*.

Cell 3c. Length 11 mm., egg in the same position as in 3b. One *G. cruciatus* in 24 hours crawled 10 mm. in a tin and laid 5 eggs on the bottom. Prey 16 females and 2 nymphs of *E. westwoodi*, and 1 female of *G. cruciatus*.

Mr. J. V. Pearman added the following notes :—

" All the species captured with the exception of *G. cruciatus* are bark dwellers.

" The preponderance of *E. westwoodi* suggests that the captor had discovered a colony or colonies of that species, but the absence of males is rather surprising. If the prey were taken indiscriminately from a colony, one could reasonably expect a few males to be included in over 120 specimens. The species has two or three broods a year, and although the males become scarce towards autumn, there should have been some about in August. This absence of males may of course be due to mere chance, but one cannot help wondering whether the females are picked preferentially, or whether the males escaped because of superior agility."

With regard to the egg-laying of *R. clavipes*, apparently the eggs are always laid at the inner end of the cells, after the cells have been provisioned, though how this is done I do not know.

One nest with eight cells was kept for breeding purposes. When fully fed the larvae spun conical, brown, papery cocoons with the remains of their food spun on the outside. The adults emerged in 1937 between the 7th and 10th of June, and only two were males. The males were numbers 1 and 3 from the outer end of the straw.

Psenulus atratus (Fab.).

The prey was Aphididae, nymphs and adults. The internal diameter of the straws used varied between 2 mm. and 3 mm., and the nests ended at the first node. Partitions between the cells were very thin and were formed from particles of straw. All the prey were dead, and those in the older cells were beginning to blacken.

The species and numbers of the prey were as follows: *Macrosiphum pisi* (Kalt.), 216 nymphs, 18 adults; *Megoura viciae* (Kalt.), 103 nymphs, 11 adults; *Amphorophora cosmopolitanus* Mason, 67 nymphs, 35 adults; *Aphis* sp., 26 nymphs, 1 adult; *Myzocallis tiliae* (Linn.), 21 nymphs, 1 adult which was winged, and was the only winged individual found in any nest; *Myzus* sp., 1 adult.

The nests were all taken on the 27th and 28th of August.

Nest 4. Six cells were complete, and 1 Aphid had been collected for a seventh.

Cell 4a. Length 7 mm., egg at the outer end. Prey, 1 nymph of *Aphis* sp., 13 nymphs and 9 adults of *A. cosmopolitanus*, 3 nymphs of *M. pisi.*

Cell 4b. Length 7 mm., egg near middle, though towards outer end. Prey, 3 nymphs and 1 adult of *Aphis* sp., 6 nymphs and 6 adults of *A. cosmopolitanus*, 1 injured adult of *Macrosiphum* sp., 10 nymphs of *M. tiliae*, 1 adult of *Myzus* sp.

Cell 4c. Length 7 mm., egg near inner end. Prey, 12 nymphs of *Aphis* sp., 12 nymphs and 3 adults of *A. cosmopolitanus*, 8 nymphs and 1 winged adult of *M. tiliae.*

Cell 4d. Length 7 mm., young larva near the middle. Prey, 3 nymphs of *Aphis* sp., 12 nymphs and 7 adults of *A. cosmopolitanus.*

Cell 4e. Length 8 mm., young larva near the middle. Prey, 7 nymphs of *Aphis* sp., 10 nymphs and 6 adults of *A. cosmopolitanus*, 1 nymph of *M. pisi*, 2 nymphs of *M. tiliae.*

Cell 4f. Length 8·5 mm., larva half-grown, and had eaten all but 11 Aphids. Prey, 7 nymphs and 3 adults of *A. cosmopolitanus*, 1 nymph of *M. tiliae.*

Nest 5. Three cells were complete and one was unfinished.

Cell 5a. Unfinished, no egg. Prey, 24 nymphs of *M. pisi.*

Cell 5b. Length 9 mm., egg near the middle. Prey, 21 nymphs of *M. pisi.*

Cell 5c. Length 9 mm., egg near inner end. Prey, 16 nymphs of *M. pisi* and 1 adult of *A. cosmopolitanus.*

Cell 5d. Length 10 mm., young larva at inner end. Prey, 11 nymphs of *M. pisi*, 10 nymphs of *M. viciae*, and 1 nymph of *A. cosmopolitanus.*

Nest 6. Two cells were complete and one was unfinished.

Cell 6a. Unfinished, no egg. Prey, 17 nymphs of *M. pisi.*

Cell 6b. Length 9 mm., egg at the inner end. Prey, 22 nymphs and 1 adult of *M. pisi.*

Cell 6c. Length 10 mm., egg near inner end. Prey, 21 nymphs of *M. pisi.*

Nest 7. Two cells were complete and one was unfinished.

Cell 7a. Unfinished, contained 16 Aphids and no egg.

Cell 7b. Length 9 mm., egg near middle. Prey, 23 nymphs of *M. pisi.*

Cell 7c. Length 18 mm., very young larva at outer end. Prey, 13 nymphs of *M. pisi.* The prey was not packed tightly as usual, but was spread out.

Nest 8. Two complete cells and one unfinished. The innermost cell contained a young larva and 30 prey which was kept for breeding purposes, but unfortunately it died during the winter.

Cell 8a. Unfinished, no egg. First barrier 65 mm. from entrance of straw. Prey, 7 nymphs and 6 adults of *M. pisi*, 5 nymphs and 1 adult of *M. viciae.*

Cell 8b. Length 8 mm., measurements of egg : 1·3 mm. long, 0·25 mm. wide. Prey, 8 nymphs and 7 adults of *Macr. pisi*, 14 nymphs and 3 adults of *M. viciae.*

Nest 9. Three complete and one unfinished cell. The innermost cell contained a young larva and 24 Aphids which was kept alive, but it died during the winter.

Cell 9a. Unfinished, no egg. Prey, 1 nymph and 1 adult of *Macr. pisi*, 5 nymphs and 1 adult of *Meg. viciae.*

Cell 9b. Length 8 mm., egg present. Prey, 1 nymph and 1 adult of *Macr. pisi*, 18 nymphs and 2 adults of *Meg. viciae.*

Cell 9c. Length 8 mm., egg present. Prey, 1 nymph and 1 adult of *Macr. pisi*, 13 nymphs and 4 adults of *Meg. viciae.*

The first barrier was 100 mm. from the entrance of the straw.

Nest 10. One complete and one unfinished cell. First barrier 87 mm. from entrance.

Cell 10a. Unfinished, no egg. Prey, 2 nymphs of *Macr. pisi*, and 24 nymphs of *Meg. viciae.*

Cell 10b. Length 14 mm., egg present. Prey, 19 nymphs and 1 adult of *Macr. pisi*, 1 nymph of *Meg. viciae.*

Nest 11. Four complete cells and one unfinished. All of the *Psenulus* larvae and eggs were kept alive, but they all died. The prey of the unfinished cell was as follows : 5 nymphs of *Macr. pisi*, and 13 nymphs of *Meg. viciae.*

With regard to the prey, *Macr. pisi* and *Meg. viciae* which were the two commonest Aphids in the nests, both occur on various Leguminous plants (Theobald, 1926, **1** : 127 and 173), but the other species have a wider range. Professor Essig added that *Amphorophora cosmopolitanus* Mason is now considered to be the same as *A. sonchi* (Oestland).

The larvae of *P. atratus* did not spin cocoons when fully fed, but they spun silken membranes across the partitions, and as a lining over the inside of the straw. Possibly this lack of cocoon accounted for the high mortality of the hibernating larvae when they were put into separate glass tubes. However, I managed to obtain four adults from one nest of eleven cells, which I kept. In two cells either the eggs failed to hatch or the female omitted to lay in them, of the rest only numbers 2, 5, 7, 10, numbered from the outside, emerged, between the 19th and 25th of June, 1937, and all were males. Pupation took place in the spring.

Trypoxylon attenuatum Smith.

The prey was spiders, usually young, in fact often so young that Dr. Jackson found it impossible to identify them. Partitions between the cells were made of mud.

The species of prey identified were as follows : THERIDIIDAE, *Theridion bimaculatum* L. ; LINYPHIIDAE *Linyphia clathrata* Sand., *Bathyphantes pullatus* Camb., *B. gracilis* Bl., *Leptyphantes tenuis* Bl. ; ARGIOPIDAE, *Meta segmentata.*

Nest 12. Two cells were complete, and one was unfinished.

Cell 12a. Unfinished; there were 6 spiders and an egg was present. All but one were identified as follows : 2 immature *L. clathrata* ; 2 males, 1 adult and 1 immature of *L. tenuis* ; 1 female *B. gracilis.*

Cell 12b. Length 25 mm., there were 10 spiders and an egg. Seven only were identified as follows : 1 immature *L. clathrata* probably ; 1 adult female, 1 male and 1 female very young, and 1 abnormal female *L. tenuis* ; 1 very young female *T. bimaculatum* ? ; 1 female *B. pullatus.*

Cell 12c. Length 15 mm. ; there were 8 spiders and an egg. All but one were identified as follows : 4 immature *L. clathrata* ; 2 female *B. pullatus* ; 1 very minute Argiopid probably *M. segmentata.*

Nest 13. There was only one cell and that was unfinished. The cell contained 8 spiders and an egg at the outer end. Six of the spiders were identified as follows: 3 adult female *T. bimaculatum*; 1 female *B. gracilis*; 2 female *B. pullatus*.

Nest 14. Again there was only one cell and that unfinished. There was a number of mouldy spiders at the inner end of the straw, partitioned off with mud, presumably being a cell from the previous year in which the larva had failed to develop. The present year's cell contained 8 spiders and no egg. All but one of the spiders were identified as follows : 1 female and 3 very young (this species ?) *T. bimaculatum*; 1 female *L. tenuis*; 2 large *L. clathrata.*

Trypoxylon clavicerum Lepel.

Very similar to *T. attenuatum*, but the species of prey were different: Linyphidae, *Linyphia clathrata* Sand., *Linyphia* sp. ?, *Bathyphantes* sp. ?, *Leptyphantes tenuis* Bl.; Argiopidae, *Tetragnatha* sp. ?, *Meta segmentata*, *Araneus* sp. ?, *Cercidia prominens* West.

Nest 15. One cell was complete and one was unfinished.

Cell 15a. Unfinished, there were 10 spiders and no egg. All but one were identified as follows: 2 immature *Linyphia* sp. ?, 1 *Bathyphantes* sp. ? very young; 1 *Leptyphantes* sp. ? ; 1 adult female and 3 immature *L. tenuis*; 1 immature male *C. prominens*; 1 very young Argiopid.

Cell 15b. Length 11 mm. ; there were 26 spiders and an egg near the outer end. Only 9 spiders could be identified as follows : 3 immature *L. clathrata*; 3 *Araneus* sp. ? ; 2 *Tetragnatha* sp. ? ; 1 very young *Leptyphantes* sp. ?

Nest 16. Only one cell was present and that was unfinished. The cell contained 4 spiders and there was no egg. The spiders were 3 immature females of *M. segmentata* and 1 very young probably a *Tetragnatha.*

Trypoxylon figulus (Linn.).

Only one nest of this species containing an unfinished cell was taken. The cell contained 10 spiders and no egg. Eight of these were identified as immature *Bathyphantes* probably *B. pullatus* Camb.

Dr. Jackson added the following notes concerning the preys of the three species of *Trypoxylon* :—

" There are at least 12 species here, but I cannot identify all certainly on account of their extreme youth. Three families of spiders are represented, and there is some evidence that *T. clavicerum* preys chiefly on Argiopids, which spin geometrical webs. However, these very young specimens may easily have been obtained elsewhere, as they do not usually spin so young. The *Cercidia* is, however, large enough. All these three families are sedentary web-spinners."

Four nests were kept for breeding purposes. All were taken complete from the summer-house roof—they were easily found, as full straws had their openings closed by mud. They were all reared successfully, two nests being of *T. clavicerum*, one of *T. figulus*, while the fourth was parasitised by the Chalcid *Melittobia acasta* (Walker). In all of the nests there was an empty space after the end barrier and before the outer barrier of the first cell (see also Hamm and Richards, 1930 : 118). The larvae spun conical cocoons of pale yellow silk, with the wider end outwards, whilst the inner end contained a black mass of larval exuvia and faeces. All, including the parasites, emerged between the 27th and 30th of June, 1937. The details of the nests are as follows :—

T. clavicerum. First nest, outer empty space 11 mm. long, and there was only one cell, which contained a male. Second nest, outer empty space 12 mm. long, followed by three cells which were 9 mm., 10 mm., 14 mm. long respectively. The outer cell contained a male and the two inner ones females.

T. figulus. The straw had been used previously by another wasp, and contained a number of broken mud barriers as well as three new cells. The outer empty space, 21 mm. long, was followed by the first cell 12 mm. long. After this there was an empty space for 8 mm., the barrier at the inner end being that of the second cell 8 mm. long, followed by the third cell 9 mm. long. Following the complete barrier of the last cell were broken barriers at distances of 5 mm., 8 mm., 7 mm., apart respectively, and then there was an empty space of 21 mm. to the first node. Again the outer cell contained a male and the inner two, females.

Melittobia acasta. The nest contained four cells, in all of which the *Trypoxylon* larvae had spun cocoons, and there were two empty spaces at the outer end of 10 mm. and 11 mm. respectively. Starting with the outer one, the cells were 10 mm., 12 mm., 12·5 mm., 14 mm. long respectively. Two males emerged from the outer cell, one male and two females from the second, one male from the third, and nine females from the fourth. The males are brachypterous and the females macropterous. The low numbers in the first three cells can probably be explained by the cannibalistic habits of the larvae, and by the habit of the males of killing the females and each other; the fourth cell with its nine adults contained no males (Balfour-Browne, 1922 : 360).

The nesting and habits of *Trypoxylon* spp. have been recorded by several authors in the past (see Hamm and Richards 1930 : 118–121), but this is apparently the first time that considerable numbers of prey of *Rhopalum clavipes* (see Hamm and Richards, 1926 : 318) and of *Psenulus atratus* have been collected and named, and the results published.

The prey have been placed in the Hamm Collection in the Hope Museum, Oxford.

LITERATURE QUOTED.

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HAMM, A. H., and RICHARDS, O. W., 1926, Biology of the British Crabronidae. *Trans. R. ent. Soc. Lond.* **74** : 297–331.

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THEOBALD, F. V., 1926, *British Plant Lice*, **1** : 127 and 173. London.

BOOK NOTICE.

A Glossary of Entomology. Smith's "An Explanation of Terms Used in Entomology." Completely revised and rewritten by J. R. DE LA TORRE-BUENO. (Brooklyn Entomological Society.) 8vo. Lancaster, Pa., 1937. pp. ix + 336, 9 pls. Price $5.00.

In 1906 the Brooklyn Entomological Society published Smith's book referred to in the title above; this extended to 154 pages, and included some 4500 terms. In the intervening 30 years Entomology has developed in all directions and, in fact, many new phases have emerged, so that the older book no longer covers all the ground.

Mr. de la Torre-Bueno's book extends to 336 pages and includes 10,000 terms, an increase of over 100%, and aims to cover all phases of Entomology, together with certain essential "border-line" subjects.

In addition to the main part of the book, devoted to explanation of terms, two appendices are added, one of abbreviations and the other of arbitrary signs and symbols. A short bibliography completes the text and ten plates giving anatomical and venational details complete the book.

THE EPIGAMIC BEHAVIOUR OF THE TERMITE *MICROTERMES SUDANENSIS* SJST. OBSERVED AT KAGELU, YEI, EQUATORIAL PROV., ANGLO-EGYPTIAN SUDAN. ECONOMIC IMPORTANCE OF TERMITES TO THE NATIVE AZANDE.

By Dr. J. G. Myers, D.Sc.

[The following interesting notes were sent by my friend Dr. Myers, together with tubes of specimens bearing the locality and the number 6401. All were kindly named by Mr. F. G. M. Westropp in the Brit. Mus. (Nat. Hist.), where they were compared with a co-type of *Microtermes sudanensis*.—E. B. Poulton.]

Kagelu, Yei, Equatorial Province, Sudan.
25 *June*, 1937.

I send under separate cover some termites illustrating the habit of biting the female during courtship. I never saw anything like it in Invertebrates before. It is mentioned in a recent note in our *Proceedings*. It is real " cave man " stuff.

The following is transcribed from my journal :—

" Kagelu : 30 March, 1937.—Winged termites at light between 7 and 8 p.m. At least half chasing each other or holding on, with mandibles, to the tip or side—mostly tip—of the females' abdomens, like bulldogs : several males often on one female, each interlocked group being preserved in a separate tube. Some of the males are still maintaining their hold in the alcohol after being killed with cyanide. Even when completely suspended and entangled in spiders' webs males were still fighting for a place at a female's side or still hanging on. Sometimes the males were winged and the females de-alated, or *vice versa*. In one instance two males were pursuing one female, trying hard to get a grip, but she always fought violently, even turning complete somersaults. When I disturbed them by removing the female, they turned on each other and attacked furiously, each trying to take hold on or near the *mandibles* of the other, thus proving that each was not mistaking the other for a female. Their mandibles clashed like stags' horns, and one could almost fancy that the sound was audible. I have made no microscopic examination, but assumed the sexes from the behaviour. All can be checked, as fighting and mating sets are all kept separate. There is also included a tubeful collected at random for identification."

[The sets of termites received from Dr. Myers were in five tubes and have been sexed by Dr. B. M. Hobby. Each tube contained 1 ♀, the numbers of males being, 1, 2, 2, 3, 3, respectively. The random collection contained 7 ♂♂, 5 ♀♀, one male being mutilated so that its sex was difficult to determine. No tube contained only males.

In these very interesting records Dr. Myers confirms and extends the observations recorded by Prof. G. D. Hale Carpenter in 1936, *Proc. R. ent. Soc. Lond.* (A) **11** : 93–94 : viz. those of Burtt on an unnamed termite in Tanganyika Territory ; Kofoid ; and Fuller on four S. African species. All the observations, including those of Dr. Myers, appear to concern the methods of courtship alone, and not to include copulation which may perhaps take place underground. —E. B. P.]

Incidentally termites of many kinds are immensely important in the economy of the Azande, among whom I have just been working. One of the greatest problems the administration faces with the Azande is diet-deficiency, especially in animal proteins. For sleeping-sickness control they have *all* been concentrated on the roads; so that hunting covers a much smaller area, and tsetse debars them keeping livestock while the Government prevents them from eating each other. In these circumstances termites form their chief animal food and they know far more about the swarming habits, which seem to be very specific, than any entomologist. They collect them in incredible quantities. I have tasted them roasted with a little salt, and they are excellent —much better than shrimps—entirely free from the cockroachy odour and taste I somehow expected. In addition to eating the termites themselves they press out an excellent, odourless yellow oil, which at least in some considerable sections is the chief cooking fat throughout the year, used far more extensively than sesame. I am getting some of it analysed officially. Who knows what potent vitamins it may contain !

In addition to the use of termites as food, the natives consult them as oracles. They take two small sticks of two different kinds of wood and thrust them, with the appropriate spells, into an opened gallery of a large termitarium, but only one built by certain species. According as one or other stick is gnawed (or both) in the morning the answer to the question put is negative or affirmative, or qualified. This is described in minute detail by Evans-Pritchard in his absorbing and magnificent work, *Witchcraft, Oracles and Magic Among the Azande* (Oxford, 1937).

I have collected about 15 species, with Azande names and lore, and sent them for identification direct to Dr. Snyder, of Washington.

I have some other very interesting pinned insects, including a huge Drilid I am now in the middle of studying, which tackles large snails, 3 inches long and more, with no subtilty but a direct attack.

Book Notice.

Animal Communities in Temperate America as Illustrated in the Chicago Region. A Study in Animal Ecology. Geographic Society of Chicago Bulletin No. 5. University of Chicago Press (U.S.A.); Cambridge University Press (Great Britain and Ireland). Pp. xiii + 368, 306 figs., 68 tabs., 9 diagrams, 2 maps. Price 13*s.* 6*d.*

This book is the second edition of a work first published in 1913. It has 15 chapters devoted to the following subjects : Man and animals; The animal organism and its environmental relations; The animal environment: its general nature and its character in the area of study; Conditions of existence of aquatic animals; Animal communities of: Large lakes; Streams; Small lakes; and Ponds; Conditions of existence of land animals; Animal communities of the tension lines between land and water; Swamp and flood-plain forests; Dry and mesophytic forests; Thickets and forest margins; Prairie animal communities; and General Discussion.

An appendix is concerned with methods of study, and there is a bibliography of references in the order of their first quotation and a supplement bringing it up to March 1937. An index to authors and a full subject index completes the book.

Essentially this book is a reprint of the first edition with errors corrected and the addition of a table to show the corrections made in the past 25 years to the nomenclature of communities. The book was originally written to give a convenient background of organisation for natural history instruction, and this is largely responsible for its restriction to the area dealt with.

NOTES ON JONES' ICONES (LEPIDOPTERA)

By G. A. Waterhouse, D.Sc., B.E., F.R.E.S.

(With footnotes and Appendix by Sir Edward B. Poulton.)

Through the courtesy of Professor G. D. Hale Carpenter, I was enabled, in August 1936, to give a hurried glance to the six bound volumes of Jones' Icones at the University Museum, Oxford. As I had at the same time to examine certain types of Australian butterflies, described from the Hope collection, sufficient time was not available for more than a brief look through these fine paintings. I saw, however, that they had an important bearing on the early history of the Australian butterflies and so arranged for another visit in September in company with Mr. G. Talbot, who assisted me materially in coming to the following conclusions. The account given here may help other workers, as these paintings were produced at a time when the scientific naming and description of butterflies was in its infancy. Many were depicted from specimens in collections which have been dispersed. My examination was confined almost wholly to the paintings of the Australian species.

I cannot add anything to what has already been said regarding the beauty of the paintings and their excellent state of preservation. None can be less than 118 years old and some must be over 150 years old. William Jones must have been a competent Lepidopterist, for he was the first to recognise the sexes of *Heteronympha merope* Fabr., many years before this was noted in any scientific publication. I am sure that a more careful study of his work would show that he was much in advance of his time.

The number of volumes.

Owing to different numbers for the volumes having been recorded and also the fact that the Fabrician citations do not always agree with the volumes as now bound, it was necessary to see if this could be reconciled.

Westwood, 1872 (*Trans. ent. Soc. Lond.*, **1872**: 107, note), states that in 1871 there were seven volumes. The Report of the Hope Professor of Zoology, 1925: 18, quoting Westwood in manuscript, speaks of five volumes. The number of bound volumes now at Oxford is six.*

This difficulty was at once cleared up when I found that volume II as at present bound really consisted of two parts each with a separate title page, table of contents and paged separately. The present volume II comprises the original volumes 2 and 3. The Fabrician citations for the Icones volumes are therefore, from volume 3 onwards, one higher than as at present bound. This agrees with those species I have tested. Since Westwood mentions seven volumes in 1871, rebinding must have taken place since that date.† There seems also to have been some slight rearrangement of the plates at some time, since a few of the Fabrician citations do not agree, but these may only be printers' errors.

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* The evidence brought forward in the Appendix proves that six volumes (of which the second includes two of those quoted by Fabricius) existed in 1871, that probably, as Dr. Dawtrey Drewitt believes, the present binding was ordered by William Jones himself, that Westwood was mistaken in conveying the impression that there were seven bound Volumes in 1871 (p. 14) and 1872 (p. 14), and that when his MS. recorded "5 volumes" (p. 16) he was certainly referring to Vols. I–V of the bound series and omitting Vol. VI with which he was not concerned in the green-bound volume of manuscript in the Hope department of Entomology.—E. B. P.

† See the above footnote.—E. B. P.

I hazard the opinion that the plates were first numbered in arabic figures in pencil near the top right-hand corner and later on, in most cases, altered to roman figures in Indian ink, perhaps after the death of Jones, since the ink of the roman figures has not faded so much as the writing underneath the paintings which I consider undoubtedly to be that of Jones. Volume I is dated 1783, volume II (as now bound), part 1, 1784, part 2, 1785, volume III, 1785. The remainder are not dated as far as I could find.* These dates probably have little value beyond indicating the year in which the plates were collected together or the volume begun. Blank pages were left in some volumes for additions. For instance, two species in volume III (dated 1785), pl. LIV, could only have come from Sydney *after* the founding of the Colony of New South Wales in 1788. Vol. VI (the old volume 7) consists chiefly of copies of the rarer butterflies from other publications such as Cramer and Clerck.

Fabricius, Banks and Jones.

These remarks are based on my examination of the Australian butterflies in the Icones: The preface to Fabricius, 1792, *Entomologica Systematica*, **1**, where an account is given of the times he visited England and the collections he examined: Hope's translation of the autobiography of Fabricius, *Trans. ent. Soc. Lond.*, **4** (it should be noted the first and last years given in these two are not quite in accord): F. D. Drewitt, 1928, *The Romance of the Apothecaries' Garden at Chelsea*, 3rd Edition: The account of William Jones of Chelsea given by Sir E. B. Poulton 1934, in *Trans. Soc. Brit. Ent.*, **1** : 139–149.

Fabricius met Banks in London in 1767–8 and again after the return of Banks from Australia. In 1775, Fabricius, *Syst. Ent.*, described the Australian species Banks had obtained, undoubtedly before Jones had made his paintings of some of them. I have examined these types now in the British Museum, South Kensington, very carefully and the only species amongst them that could not have been caught at the Endeavour River, where Cook's vessel was beached, is *Papilio merope* Fabr. which must have been caught on the south side of Botany Bay. Only one other Australian species (*P. harmonia*) was described by Fabricius at a later date from the Banks collection. In the Icones most of these species are to be found.

It seems important to establish the date when Fabricius examined the Icones. It must be remembered that Fabricius described all insects and would not be able to spare a great deal of time for the butterflies. There is definite evidence published by Poulton (*loc. cit.* : 149) that Fabricius was examining the Icones in August 1787. This I believe to be the only time that Fabricius examined the Icones for the purpose of making descriptions.†

In the Icones the Australian species described by Fabricius, 1775, *Syst. Ent.*, and painted by Jones are not referred to that work, but above the paintings and to the left we find a record of the number of the species as it appears in 1782, *Species Insectorum*, 2. It has always been a puzzle to me how the species described by Fabricius, 1793, *Ent. Syst.*, reached England as, with one very unlikely exception, they were not from Sydney, but are North Queensland species. Now as Fabricius saw them in 1787 and quoted the Icones they must have reached England some time prior to 1787. I have little doubt that others besides Banks brought insects to England from Cook's first voyage. There is proof of this in the advertisement to Donovan's *Insects of New Holland* in the case of Bailey, the Astronomer. Specimens brought in this way would be more likely to reach collections other than that of Banks. I am therefore of opinion that the species described by Fabricius in 1793 also came from the Endeavour River. As far as I am able to ascertain no vessel called at the Queensland coast until after possession was taken of Australia in 1788. The Australian species described by Fabricius in 1793 are all in the Icones and painted from species in several collections.

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* Vols. IV, V, and VI are all dated 1785 on the spine: see p. 17.—E. B. P.

† See p. 15 and footnote.—E. B. P.

The third species of Australian butterflies in the Icones consists of two species (*smilax* and *aganippe*) which were named and described by Donovan but without reference to the Icones. Donovan's figure of *P. aganippe* is undoubtedly taken from the Icones, in which both these species are without names. These two species were some of the first, if not the first to reach England from Sydney, after 1788.

The fourth series of Australian paintings were of a still later period, all from very near Sydney, all unnamed in the Icones and, with perhaps one exception, evidently not seen by Donovan, who although he described three of them, gave figures different from those of the Icones and in two cases of the opposite sex.

Jones and Donovan.

It has always been considered that the illustrations of the butterflies in Donovan's 1805, *Insects of New Holland*, other than those described by the author himself, were taken direct from the Fabrician types in Banks' collection. This is certainly not the case, as I shall prove.

Soon after my arrival in London, I carefully examined the Australian types in the Banks collection in conjunction with Donovan's *Insects of New Holland* and made notes of some rather startling discrepancies which I could not explain. I was well acquainted with Westwood's account (*Trans. ent. Soc. Lond.*, **1872** : 105–9) of the carelessness of Donovan, but was scarcely prepared for what I found.

It is necessary to describe Jones' method. His plates consisted of the upperside and underside of one, two or four species according to size, with name in most cases above the centre of the paintings, the reference to a description to the left of the name (this reference being always to Fabricius in the species with which I was concerned), and the owner of the specimen to the right.

I took my notes and compared the Icones paintings with Donovan's illustrations. As Fabricius only used *Papilio* and *Hesperia* as genera, I will apply the specific names (which alone are of importance here) with the genera as at present used. I will not go into detail regarding all the species but take the more outstanding cases.

Eurycus cressida Jones, I, xxxiv. Donovan's figure although close to the holotype male, did not agree with it, but did agree very well with Jones, whose painting was taken from a Drury specimen.

Eurycus harmonia (= *E. cressida* female) Jones, I, xxxv. Here Donovan's figure showed very marked differences from the holotype female, especially at the apex of the fore-wing. This illustration was obviously copied from the Icones, which again was from a Drury specimen afterwards acquired by Donovan.

Catopsilia pomona Jones, II (pt. 2), xxxv. Here again the differences between the holotype female and Donovan's figure were explained, since he had copied and exaggerated the figure in the Icones which was from a Francillon specimen.

Delias aganippe Donovan. This species is unnamed in the Icones II (pt. 2), lx, but Donovan's illustration shows that he had copied it. The holotype female is a Francillon specimen.

Euploea sylvester Jones, II (pt. 2), lxvii. Westwood (**1872** : 108) has already exposed Donovan's method in regard to this species. Donovan, *Naturalist's Repository*, pl. CXXIX, said that the figures are copied from the original insect described by Fabricius in the cabinet of the late Wm. Jones. We know from the material at Oxford that Donovan made a tracing of the upperside which was fairly good and made notes of the underside. As a result he produced an underside quite unlike the Icones plate which he quotes.

Melanitis bankia Jones, III, vii. This figure is from a Drury specimen (which Donovan acquired afterwards), of which Donovan has illustrated the upperside only. The underside differs from the holotype female in the Banks collection.

Ypthima arctous Jones, III, xiv. Donovan's figure was always a mystery to me, as it did not agree with the description of Fabricius. When I saw the holotype I was more mystified, as it did not have a subapical ocellus on the upperside of the hind-wing, nor was it pinkish beneath as in Donovan's figure. Everything was explained by the Icones, which was from a Drury specimen. Donovan had copied that figure and exaggerated the pink underside. In this case Donovan is definite that *arctous* is from the Banksian cabinet. Hewitson, 1865, *Trans. ent. Soc. Lond.*, **1865** : 284, gave the name *Y. arctoides* to Donovan's figure.

Heteronympha merope Jones, III, xxxvi. The holotype female is in such poor condition, as might be expected from the time of the year (end of April) when it was caught at Botany Bay, that it is excusable that the painting of Jones is a poor representation of the species. What would be a surprise would be that both Jones and Donovan should arrive at almost the same result if they both painted from the holotype. The inference is that Donovan copied the Icones. Here Jones remarks, "Mr. Francillon has one as deep coloured all over as that on p. 54 which I think to be the male of the above species." On p. 54 is found a male *H. merope*, which was much later described by Godart as a distinct species and still later that they were definitely recognised as sexes. It should be noted that Jones on III, xxxvi, refers to p. 54 and not p. liv, and on III, liv, to p. 36 and not p. xxxvi.

Tisiphone abeona Donovan. Jones, III, lv. The paintings of a male of this species are unnamed in the Icones, but someone, certainly not Jones, has written lightly in pencil "*Abeona* Donov. N. Holl." Donovan described this species in *Insects of New Holland* and figured a female. He remarks, "It excites some surprise with us, that although a painting of this fine insect existed amongst the drawings of our worthy friend William Jones, Esq., of Chelsea, at the time Fabricius was in this country, he should either by accident or design have omitted mentioning it, since he had an unreserved access to those drawings, and was indebted solely to them for his descriptions of nearly all the new species of the Papilio genus included in his *Species Insectorum* and *Entomologia Systematica*."

This species (with *Heteronympha merope* male and *Xenica acantha* on the previous page of the Icones) could only have been caught near Sydney and could have reached England only after 1788, so Fabricius could not have seen them in 1787 when he was writing his descriptions for the *Entomologia Systematica*. They were no doubt there when Fabricius passed through London on his last visit in 1790 or 1791, but my opinion is that Fabricius did not visit Jones on that last trip.

Summary.

(1) The Icones originally consisted of seven volumes and after 1871* were bound as six volumes.

(2) The pages were originally numbered in arabic figures and later in roman, doubtfully by Jones.

(3) All citations by Fabricius of volumes I and II are correct, but the rest are one too high, all citations by him of volumes II and III require sorting out.

(4) Donovan drew most of his illustrations from Jones' Icones and not from the actual specimens.

APPENDIX BY SIR EDWARD POULTON.

Mr. N. D. Riley and I have entirely confirmed Dr. Waterhouse's conclusion that Vol. II of the "Icones," as now bound, includes Vol. III, as quoted by Fabricius, and that therefore the existing Volumes III to VI require to be taken as IV to VII, respectively, in order to harmonise with the references in *Entomologia Systematica.* This we verified by comparing 17 Fabrician references (*Ent. Syst.*, III, pt. 1) with the bound volumes in the Hope Department. Two references to Vol. II, pl. 36, were traced in the first part of this bound volume, while 6 references to Vol. III were traced in the second part of the same Vol. II; 3 to Vol. IV were found in Vol. III; 4 to V in IV; 2 to VI in V.† It now becomes most interesting and important to ascertain the date at which the seven volumes were bound as six, and by a most fortunate coincidence I received at the time when this problem was being considered a packet of papers, letters and proofs of plates in different stages of production, from my friend Dr. F. Dawtrey Drewitt, together with the following letter written by him on 4 Oct., 1936 :—

"My dear Poulton, years ago I began some lithographic plates from 'Jones's Icones' which Professor Westwood thought would make a paper for the Linnean Society. Westwood, of course, was to write all the scientific part. But I soon found that I could not spare the time for carrying it out, and it was put aside and forgotten. I have just come upon them, and send them off to you in case there should be anything worth preserving. Perhaps Westwood's notes and letters may be. . . . Yours very sincerely, F. Dawtrey Drewitt."

Dr. Drewitt also wrote on 8 Oct. that he had nothing to do with the binding of the six volumes of "Icones," and added, "Jones, I think, arranged for the binding—for the work was finished some years before he died." Again, on 26 Oct. he wrote : "I am almost certain that the 'Icones' were bound in Jones's time. Jones liked good bindings. Some of his books were beautifully bound and his bible, which had been bound by Charles II's bookbinder, S. Mearne, was considered one of the treasures of a Burlington Fine Arts Exhibition years ago."

Among the papers were five letters, written 1871–2, by Professor Westwood to Dr. Drewitt—then an undergraduate at Christ Church. The first of these letters makes it certain that the six volumes were in their present condition in 1871, for the words about Vol. VI apply to-day. The letters have also a special interest in showing the care with which Westwood was glad to help a student with his work in the Entomological Department, a kindness of which I had happy experience a few years later.

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* Certainly before and probably very long before this date.—E. B. P.

† Hence the "Vol. V," quoted on pp. 98–9 of 1929, *Proc. R. ent. Soc. Lond.*, **4**, and on p. 148 of 1934, *Trans. Soc. Brit. Ent.*, **1** (2), refers to the existing bound Volume corresponding with Vol. VI of the Fabrician references.

(1) May 16, 1871, from Oxford Museum :—

"I return you Jones' Icones Vol. 1 & 6. The latter are entirely copied from various published works. I have carefully annotated each of the species in Vol. 1, and find that there are 6 or 8 which ought to be figured. I have the name of the lithographer from Mr. Hewitson. Please send Vol. 2 by bearer."

(2) The next letter was written from Westwood's house, Walton Manor, Woodstock Road, Oxford, "31.5.71., 8½ p.m." :—

"I have been since dinner into Oxford to find you without success. They gave me a wrong address in Walton St., and I knocked at half the doors in St. John St. Let me know your number and I will come to you on Friday at 3 or 4 p.m., and give you a lesson in Lithography. Have some rain water or soft water boiled beforehand to free it from greasy particles, and be very careful not to touch the surface of the stone as every pore of the skin tells on it by contact."

(3) The third letter from "Oxford 10th–Nov^{r} 71" must have been encouraging :—

"My dear Drewitt, I am very glad to hear of your progress in lithographic drawing. I was sure you would find it interesting work. My friend, Mr Hewitson, never leaves home after the middle of October on account of his health. I am going to pay him a short visit for a couple of days on Saturday the 18th. If you should be in Oxford on the Friday and would entrust the Thecla volume with me till the Tuesday following, he would be greatly obliged, and I would be surety for its safe return."

(4) Westwood, in the fourth letter, from "Oxford 6 May 1872," writing of an impression sent to him as "a great improvement on the former" and of certain figures being "excellent," gives advice on the details of the drawing and method of numbering the figures. A postscript refers to his article in the last number of *The Academy* in which he had "alluded to Mr. Jones' plates."

(5) The last letter, "Oxford 26 Nov^{r} 1872," contains advice on the saving of space by figuring the upper surface of the wings of one side and under surface of the other, and concludes : "Thanks for your invitation : if I can avail myself of it I shall be very happy to do so, but lunch-time is generally the hour when I am the busiest in London at one museum or other."

The identification of Vol. VI in Westwood's first letter is especially important because his statements, published about a year later, convey the impression that there were then seven bound volumes. This is the natural interpretation of his note, *Trans. ent. Soc. Lond.* **1872** : 105 :—

"At the present time (1871), the seven large quarto volumes, into which this collection of drawings is bound, belong to . . . F. Dawtrey Drewitt, Esqr., of Ch. Ch., Oxford . . . who proposes to publish the unfigured and doubtful species represented therein, and who has allowed me to make a very careful collation of the entire collection."

The same impression is conveyed by Westwood's article in *The Academy*, **3**, No. 47, of 1 May, 1872. He here states on p. 168 :—

"It was in Mr. Haworth's cabinet that we were able to find references to the wonderful volumes (seven in number) of drawings of exotic butterflies made during the last quarter of the eighteenth century by Mr. Jones, so constantly referred to by Fabricius, from which, indeed, from time to time, Donovan professed to publish copies of rare species only to be found represented in those delineations."

Most fortunately the manuscript, dated 1871, of Drewitt's Introduction and Contents of his unpublished work were included in the parcel. The title was to have been: "Illustrations of Exotic Butterflies described by Fabricius from the Drawings of Jones." These priceless drawings are thus described: "'Jones Icones,' as they are usually called, are in seven quarto volumes and contain water colour drawings of nearly a thousand species of butterflies. . . . The whole work is said to have occupied thirty years." The "seven quarto volumes" certainly refer to the seven parts quoted by Fabricius, as proved by Drewitt's detailed list included in his manuscript. Furthermore Dr. Drewitt informs me that his list of seven volumes was drawn up from the existing six bound volumes, so that he had recognised, as Dr. Waterhouse has, the title-pages of two parts in Vol. II.

Considering the whole of the evidence, especially Dr. Drewitt's list and the above information, Prof. Westwood's description of the existing Vol. VI in 1871 on p. 14, and his MS. title-page of the "green-bound volume" (p. 16) referring to the five preceding volumes, one is driven to conclude that his references (also on p. 14) to seven bound volumes in 1871 and 1872 are a mistake probably caused by confusion between the original series studied by Fabricius and the volumes bound at a somewhat later date.

One may, I think, safely conclude that William Jones arranged his plates and manuscript in seven parts, giving title-pages to some of them, and it was in this condition that they were seen by Fabricius. When later on he decided to have them bound, Pt. III would have made so thin a volume that probably on this account he combined it with the preceding, making the single Vol. II, as shown by the words "Heliconii et Danai" printed on the spine and by the two title-pages within the volume (p. 9).

The importance of the subject is so great, and the statements concerning its history so conflicting, that I trust the amount of space devoted to its consideration will not be deemed excessive.

Dr. Drewitt's MS. Introduction also states that William Jones was born in 1745, and that when about 35 "he appears to have possessed a considerable fortune which enabled him to devote the best part of his life to his favourite pursuits, Natural History and Painting. . . . Fabricius was his guest on each of . . . three visits to England." Birth in 1745 would have made William Jones 73 when he died in 1818, whereas Faulkner * gives his age as 83. Fabricius paid many visits to England from 1767, when he rode from Edinburgh to London and sold his horse, "with loss" on arrival. A full account of his visits between 1767 and 1791 is given in Rev. F. W. Hope's translation of the auto-biography.†

In the concluding paragraphs Drewitt wrote concerning the "Icones": –

"Some years ago part of the Br. Mus. Collection was named from them. Donovan too copied many of them, but from caring more for beautiful pictures than for Entomology, many of his copies, though gems of colour, are very

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* See 1934, *Trans. Soc. Brit., Ent.*, **1**: 140 and footnotes. See also p. 149 for evidence that Fabricius was visiting Jones in 1787 and would probably do so later.

† 1845–47, *Trans. ent. Soc. Lond.*, **4**: i–xvi.

inaccurate, and Professor Westwood tells me that some of them, especially those of undersides, were made from written descriptions alone.

"My object has been to publish figures of those species of butterflies of which drawings have never yet been published, secondly of those which have been untruthfully copied, and thirdly of such species as have given rise to uncertainty of identification."

Then follows a list of the seven volumes as quoted by Fabricius, the title-pages being copied or stated to be absent, the indices mentioned and any in the MS. of Fabricius specially noted.

With the manuscript introduction are several sheets of rough drawings and notes on the figures of the "Icones" by Prof. Westwood which, with the contents of the "green-bound volume" (below), will be of immense help to the future author of a comprehensive monograph on the "Icones." Proof copies of six plates, five of them dated in pencil 1871 or 1872 "F. D. D.," are also present. They include copies of two coloured plates of PIERINAE (one of them accompanied by an uncoloured duplicate) and two coloured plates of PAPILIONIDAE, with a third showing a different arrangement of similar figures. These beautiful plates add to our regret that Dr. Drewitt was unable to finish the work. "The lithographic stones," my friend tells me, "went back to Hanhart's and were probably used for many other illustrations."

Eight pages of foolscap (five of them written on both sides), contain MS. descriptions of figures on these plates with corrections or additions by Prof. Westwood, one being of great length. Dr. Drewitt had also written a long list of those figures in Vols. II—V (both included) which he doubtless hoped to copy. This list, which occupies 15 pages, and also includes much of Westwood's MS., appears to have been drawn up as a continuation of 2 pages in his handwriting affixed to his letters already described and in large part quoted (p. 14). There is no doubt, however, that most of the handwriting is Drewitt's, and one of the pages is written on Christ Church paper with the College crest.

The Green-bound Volume.

A thick, green-bound, octavo volume of manuscript and rough pen and-ink drawings in the Hopeian Library bears the title printed on the back, "Jones Icones copied by Donovan and Westwood." The title page, copied below, follows 12 blank pages and is in Westwood's MS., except "Fasciculus 1 Papiliones Equites" written by Hope :—

Donovan's Drawings of Butterflies // copied from *Jones'*, *Icones* on 76 sheets // (as formerly arranged) and divided by Mr. // Hope into "Five Fascicles." // (Many of these were published by Donovan in his // Naturalists Repository). // Fasciculus 1 // Papiliones Equites // but a great number more copies from // Jones' 5 Volumes (which were in the // Possession of Mr. Drewitt of Christ Church // Oxford, in 1872) were made by *W // at that time and incorporated with Donovan's. // Bibliotheca Entomologica Hopeiana, Oxoniae.

There is, also, written in pencil on the title-page, a list of the number of figures copied by Westwood in each of 8 sections of butterflies, the total being 569. The "Jones' 5 volumes" mentioned by Westwood are clearly shown by the MS. in the volume and on loose sheets between its pages to be I–V of the bound books, representing I–VI, quoted by Fabricius, because, as Dr. Waterhouse has shown, and as has been already mentioned, Vol. II includes two volumes, each with its title-page. The very numerous notes on determinations by Westwood, as well as his copies of figures, and the MSS. by Hope and Donovan are of great importance, and will, I believe, be of immense value in future researches. Westwood's loose notes were often written on the blank sides of printed University Notices dated 1869 and generally enclosed in folders of the same material and date.

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* Westwood's name is indicated by a very characteristic monogram combining his initials I.O.W., the I representing J.

In conclusion, I feel sure that it will be useful to print in tabular form the titles of the six existing volumes, and thus clearly show their relationship to the volumes quoted by Fabricius.

Existing bound Volumes	Titles printed on the spine and in MS. on the title-page (when present) of the existing bound volumes	Volumes quoted by Fabricius
I	*Spine*—Papiliones // Equites // Vol. I. // Jones // 1783.	I
	Title-page—Papiliones Equites Troes et Achivi delineati et picti Gulielmo Jones 1783.	
II	*Spine*—Papiliones // Heliconii // et // Danai // Vol. II. // Jones // 1785.	
	First title-page—Papiliones Heliconii delineati &c. 1784.	II
	Second title-page—Papiliones Danai Candidi et Festivi delineati &c. 1785.	III
III	*Spine*—Papiliones // Nymphales // Vol. III // Jones // 1785.	IV
	Title-page—Papiliones Nymphales Gemmati et Phalerati delineati &c. 1785.	
IV	*Spine*—Papiliones // Vol. IV // Jones // 1785.	V
	Title-page—wanting. Index to plates 1–101 in volume.	
V	*Spine*—Papiliones // Plebeii // Vol. V // Jones // 1785.	VI
	Title-page—wanting. The first pages contain a list of 149 names to figs. on pls. 1 to 95 inclusive.*	
VI	*Spine*—Papiliones // Vol. VI // Jones // 1785.	VII
	Title-page—wanting. Copies of drawings in works of various authors with alphabetical lists of "Trivial" † names of Linnaeus, Fabricius, &c.	

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* On margin of p. 1 in MS. of William Jones: "This is Mr. Fabricius's own writing, the Names given and corrected by himself." This statement also guarantees the Fabrician MS. of lists on similar paper and similarly fixed in Vols. II and III, as bound, II having two lists, one for each of its parts.

Three additional plates are present:—96 unnamed, 97 with "*acis*," 98 with "*chryseis*." The wanting title-page in this and other volumes is replaced by 2 or more blank sheets one of which in the first vol. is surrounded by marginal lines, as if for addition of MS. title.

† The use of the word "trivial" in Natural History, is thus described in the O.E.D.:—

"7. *Nat. Hist.* Applied to names of animals and plants: *a.* to a Latin name added to the generic name to distinguish the species . . ." The following example is given, with others: "**1815** Kirby & Sp. *Entomol.* (1843) I. 181 *Scolytus destructor*, whose trivial name well characterises the . . . severity of its ravages."

BOOK NOTICES.

Die Blattminen Mittel- und Nord-Europas einschliesslich Englands. By M. HERING. Neubrandenburg (Gustav Feller), 1935–1937. Lief. 1–6. pp. viii + 631, 7 plates, illust. Subscription price 12·00 Rmk. per lieferung.

This work, the various lieferungen of which have been noticed during publication, is now complete.

It is the only work of its kind devoted to leaf-mining insects, and includes those species found in Britain.

The major part of the volume is devoted to a key for the determination of leaf-miners arranged under plant genera in an alphabetical list. To assist readers a list of plants in systematic order is given and also a list of the genera of leaf-mining insects in systematic order, followed by an alphabetical index of genera and species.

15 new species of Diptera, 2 of Hymenoptera and 1 of Lepidoptera are described. A reduction in price of 25% is made to purchasers of the book resident outside Germany.

Introduction to Economic Entomology. By W. J. BAERG. Russellville, Arkansas, 1937. pp. [vi] + 72 (printed on one side of the paper).

This book is by the Professor of Entomology at the University of Arkansas and was prepared primarily for students in the University. It follows, therefore, that Arkansas insects are the types chosen for detailed description. The arrangement of the book is systematic, and all orders of insects are dealt with. Methods of control of noxious insects are explained. The book is "bound" by the "Wire-O" patent binding, which is a system used to hold together a number of pages on a wire frame somewhat as a loose-leaf binder does.

Mosaics and other Anomalies among Ants. By (the late) W. M. WHEELER. Cambridge, Mass. (Harvard University Press) and London (Oxford University Press). pp. [xiv] + 95, text illust. Price 8*s*. 6*d*.

This is a posthumous work of Professor W. M. Wheeler, who was greatly assisted in its preparation by Dr. N. Weber.

The book is concerned with a colony of *Acromyrmex octospinosus* Reich., brought from Trinidad to Cambridge, Mass., and studied there. The colony produced a high percentage of anomalous individuals, many unlike any formerly described amongst ants, or indeed any social insects.

The study of the colony led to a choice between two rival theories of caste determination, long a matter of dispute amongst students of ants.

Part 1 deals with distribution, habits and normal castes of *Acromyrmex*, Part 2 the anomalies of the colony studied, Part 3 general considerations, appendix A taxonomic notes, and appendix B a revision of the known non-mosaic female and worker anomalies of ants. A bibliography extending to 7 pages completes the book.

REPORT ON THE HEMIPTERA–HETEROPTERA TAKEN IN THE LIGHT TRAP AT ROTHAMSTED EXPERIMENTAL STATION, DURING THE FOUR YEARS 1933–1936.

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Communicated by Dr. C. B. Williams, F.R.E.S.

A light trap with a 300-candle-power electric light about 3 feet 6 inches above the level of the ground was in continuous use in the fields at Rothamsted Experimental Station, Harpenden (about 25 miles north of London), from March 1933 to Feb. 1937. A considerable number of Heteroptera have come into the trap during the period, and I am indebted to Dr. C. B. Williams for allowing me to examine them and prepare the following report on the group.

A full description of the trap will be found in *Trans. R. ent. Soc. Lond.*, **83** : 523. It is fitted with a series of eight killing-bottles, which are changed automatically by clockwork at intervals during the night. Each period is one-eighth of the time between half an hour after sunset and half an hour before sunrise. By tabulating the contents of each killing-bottle separately, it is possible to get evidence of the time of flight during the night of particular species, as has been done in the latter portion of this paper.

I am indebted to Mr. W. E. China of the British Museum (Natural History) for his assistance in determining the identity of the material.

The nomenclature used throughout this paper is that of Oshanin's *Katalog der paläarktischen Hemipteren* (1912), as used in *A Biology of British Hemiptera–Heteroptera* by Butler (1923).

The occurrence of Heteroptera at light has hitherto been noticed in only a few scattered instances; it is therefore of considerable interest to find that quite a number of species, particularly those belonging to the family Capsidae, are regularly attracted to light.

The numbers of Heteroptera from the trap during the summers of 1933–1936 inclusive were not sufficiently great for much statistical evidence to be obtained, accordingly this paper is confined to a bare statement of direct data.

Table I shows the number of each species taken in each year and the number of each sex. Table II summarises the totals and sex ratios for each family. It will be seen from these tables that the Capsidae are by far the most abundant Heteroptera to come to light both in numbers of species and of individuals. Although species of Capsidae are undoubtedly the commonest Heteroptera in summer in this country, the very high percentage of them in the trap is a fully significant indication of their greater response to stimulus by light. The Lygaeidae and Anthocoridae, which together form the bulk of the rest of the species in the field, are so poorly represented in the trap that there can be little doubt that there is a real difference in reaction to light between these families and the Capsidae.

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TABLE I.

Species		1933		1934		1935		1936		1933–6		Total
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
PENTATOMIDAE												
Sehirus bicolor L.	C	—	—	—	1	—	—	—	—	—	1	1
Acanthosoma haemorrhoidale L.	—	—	—	—	—	—	—	1	—	1	—	1
LYGAEIDAE												
Chilacis typhae Perr.		—	—	—	—	—	1	—	—	—	1	1
Taphropeltus contractus H.S.	A	—	—	—	1	—	—	1	—	1	1	2
TINGIDAE												
Piesma maculata Lap.	C	—	—	—	—	—	—	—	1	—	1	1
NABIDAE												
Nabis major Costa	A	—	2	—	2	—	3	—	—	—	7	7
Nabis ferus L.	C	—	1	1	1	1	4	—	—	2	6	8
Nabis rugosus L.	A	—	—	—	—	1	—	1	—	2	—	2
ANTHOCORIDAE												
Anthocoris confusus Reut.	A	4	—	1	—	—	—	1	—	6	—	6
Elatophilus nigricornis Zett.	—	—	—	—	—	1	—	—	—	1	—	1
CAPSIDAE												
Pantilius tunicatus F.	C	—	—	1	—	—	—	—	—	1	—	1
Phytocoris tiliae F.	A	2	—	—	—	1	—	3	—	6	—	6
Phytocoris longipennis Flor.	A	1	—	2	—	—	—	—	1	3	1	4
Phytocoris dimidiatus Kb.	S	3	—	1	—	—	—	1	—	5	—	5
Phytocoris ulmi L.	C	1	—	1	—	—	—	—	—	2	—	2
Megalocoelum infusum H.S.	C	—	—	1	—	—	—	—	—	1	—	1
Adelphocoris lineolatus Goeze	A	64	7	55	2	31	11	30	6	180	26	206
Calocoris fulvomaculatus De G.	C	1	—	—	—	—	—	—	—	1	—	1
Calocoris norvegicus Gmel.	A	—	—	2	1	—	—	—	—	2	1	3
Stenotus binotatus F.	A	32	—	13	—	12	—	23	—	80	—	80
Dichrooscytus rufipennis Fall.	C	1	—	—	—	—	—	—	—	1	—	1
Lygus viridis Fall.	A	2	—	—	—	—	—	—	—	2	—	2
Lygus spinolae Fall.	C	—	—	2	—	—	—	—	—	2	—	2
Lygus lucorum Fall.	A	1	—	—	—	—	—	—	—	1	—	1
Lygus pratensis L.	A	76	5	60	10	117	16	13	1	266	32	298
Lygus cervinus H.S.	A	4	1	—	—	—	—	1	—	5	1	6
Lygus campestris L.	A	—	—	1	—	—	—	—	—	1	—	1
Orthops kalmi L.	A	27	1	24	1	23	4	3	2	77	8	85
Plesiocoris rugicollis Fall.	C	5	—	10	—	5	—	2	—	22	—	22
Camptozygum pinastri Fall.	C	1	—	—	—	—	—	—	—	1	—	1
Camptobrochis lutescens Schill.	A	—	1	—	1	—	—	—	—	—	2	2
Stenodema calcaratum Fall.	A	3	—	4	—	9	8	13	2	29	10	39
Trigonotylus ruficornis Geoffr.	C	—	—	5	—	1	—	1	—	7	—	7
Miris dolabratus L.	A	—	—	—	—	—	—	1	—	1	—	1
Macrolophus nubilus H.S.		—	—	—	—	1	—	—	—	1	—	1
Dicyphus epilobii Reut.	A	—	—	1	—	—	—	—	—	1	—	1
Dicyphus errans Wolff.	A	—	—	1	—	—	—	—	—	1	—	1
Cyllocoris flavoquadrimaculatus de G.		—	—	1	—	—	—	—	—	1	—	1
Blepharidopterus angulatus Fall.	C	—	—	—	—	5	—	4	—	9	—	9
Orthotylus bilineatus Fall.	—	—	—	1	—	6	—	—	—	7	—	7
Orthotylus tenellus Fall.	—	—	1	—	—	—	—	—	—	—	1	1
Orthotylus nassatus F.	A	20	—	—	—	2	2	3	—	25	2	27
Orthotylus flavinervis Kb.	S	—	—	—	—	1	1	1	—	2	1	3
Orthotylus ochrotrichus Fieb.		—	—	6	—	—	—	—	—	6	—	6
Orthotylus flavosparsus Sahlb.	C	8	—	42	—	1	—	2	—	53	—	53
Orthotylus virescens D. & S.	A	—	—	1	—	3	—	—	—	4	—	4
Orthotylus adenocarpi Perr.	A	—	—	5	—	3	—	—	—	8	—	8
Hypsitylus bicolor D. & S.	A	—	—	8	—	15	—	—	—	23	—	23
Malacocoris chlorizans Panz.	C	—	—	—	—	—	—	—	1	—	1	1
Pseudoloxops coccinea Mey	C	—	—	—	—	2	—	—	—	2	—	2
Heterotoma merioptera Scop.	A	—	—	—	1	—	—	—	—	—	1	1
Orthocphalus saltator Hhn.	S	—	—	1	—	—	—	—	—	1	—	1
Onychumenus decolor Fall.	C	—	—	1	—	3	—	—	—	4	—	4
Megalocoleus molliculus Fall.	A	26	—	50	—	148	—	13	—	237	—	237
Macrotylus solitarius Mey.	A	—	—	—	—	—	—	2	—	2	—	2
Harpocera thoracica Fall.	S	—	—	2	1	—	—	—	—	2	1	3
Phylus melanocephalus L.	A	—	—	1	—	—	—	—	—	1	—	1
Phylus coryli L.	A	—	—	1	—	—	—	—	—	1	—	1
Plesiodema pinetellum Zett.	—	—	—	—	—	—	—	14	1	14	1	15
Psallus ambiguus Fall.	—	—	—	5	—	—	—	—	—	5	—	5
Psallus obscurellus Fall.	—	—	—	—	—	—	—	2	—	2	—	2
Psallus varians H.S.	A	3	—	14	8	1	—	1	—	19	8	27
Psallus diminutus Kb.	S	1	—	1	—	—	—	—	—	2	—	2
Psallus salicellus Mey.	C	3	—	8	1	3	—	1	—	10	1	11
Atractotomus mali Mey.	—	1	—	13	1	—	—	—	—	14	1	15
Plagiognathus chrysanthemi Wolff.	A	—	—	—	—	4	—	—	—	4	—	4
Asciodema obsoletum Fieb.	A	39	—	114	—	5	—	—	—	158	1	158
Family totals		325	16	452	27	404	42	134	14	131	599	1414
CORIXIDAE												
Arctocorisa hieroglyphica Duf.	—	—	—	—	—	1	1	—	—	1	1	2
Arctocorisa linnaei Fieb.	—	—	—	—	—	1	—	—	—	1	—	1
Arctocorisa striata L.	—	1	5	—	—	—	—	—	—	1	5	6
Arctocorisa fallenii Fieb.	—	1	—	—	—	—	—	—	—	1	—	1
Arctocorisa fossarum Leach.	—	2	1	—	—	—	—	—	—	2	1	3
Arctocorisa indeterminable spp.	—	—	15	—	6	2	1	—	—	2	22	24
Callicorixa wollastoni D. & S.	—	1	2	1	1	—	—	—	—	2	3	5
Yearly totals	—	376		491		463		153				
								Grand total				1486

Note :—A = abundant. C = common. S = scarce. (See text.)

TABLE II.

Family	No. of spp.	No. of individuals	% of total	No. of ♂♂	No. of ♀♀	% ♀♀
CAPSIDAE . . .	57	1414	95·15	1315	99	7·0%
CORIXIDAE . . .	6 +	42	2·83	10	32	76·0%
NABIDAE . . .	3	17	2·02	4	13	76·5%
ANTHOCORIDAE . .	2	7		7	0	—
LYGAEIDAE . . .	2	3		1	2	—
PENTATOMIDAE . .	2	2		1	1	—
TINGIDAE . . .	1	1		0	1	—

TABLE III.

Year.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jly.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1933 . .	0	0	0	2	1	4	209	144	11	3	2	0	376
1934 . .	0	0	0	1	2	53	348	80	8	1	1	0	494
1935 . .	0	0	0	0	0	0	218	236	5	1	3	0	463
1936 . .	0	0	0	1	2	17	53	58	21	1	0	0	153
	0	0	0	4	5	74	828	518	45	6	6	0	

It will be noticed in Table I that some of the specimens of CORIXIDAE could not be identified to the species. This was due to the injury of their heads and front legs caused, presumably, by their striking the glass panels around the electric lamp whilst in full flight.

Table III gives the numbers of Heteroptera taken in each month for the four years, and shows how short the period of attraction to light is for this suborder. The period from the end of June to the middle of September during which Heteroptera are attracted in greatest numbers does not correspond very closely with the observed occurrence of these species in the field. For example, many of the species of CAPSIDAE in Table I can be found abundantly throughout September and most of October.

This premature falling off in numbers may possibly be accounted for by the diminished activity (prior to death) of male CAPSIDAE after copulation, which has been observed in several species in confinement.

It may be of interest to compare the numbers of all insects taken in the four years.

	All insects	Heteroptera
1933	109,344	376
1934	103,362	494
1935	399,006	463
1936	241,822	153

From which it is seen that the Heteroptera did not join in the large increases in response in 1935 and 1936. I am unable to suggest any plausible reason for this.

There was unfortunately no opportunity of comparing the number of Heteroptera in the trap with the numbers in the field. However, an approximate estimation of the numbers of certain species occurring in the fields of the Station was made by general collecting in the fields around the trap, and the general impression (which is, of course, entirely without statistical significance) gained from this is indicated in the first column of Table I.

A = abundant (*i.e.* 100 or more specimens might be collected under suitable conditions in two or three hours).
C = common (20–50 specimens as above).
S = scarce (5 and under).

It will be seen from Table I that many species only attracted in small numbers are extremely abundant in the field (e.g. *Phytocoris tiliae* F., *Calocoris norvegicus* Gmel., *Lygus viridis* Fall., *Lygus lucorum* Fall., and *Miris dolabratus* L.), while others equally or less common in the field came repeatedly. Moreover, many of the most abundant of all CAPSIDAE around the trap never occurred at all (e.g. *Plagiognathus arbustorum* F., *Notostira erratica* L., and *Stenodema laevigatum* L.).

A study of the sex ratios given in Tables I and II shows that while the CORIXIDAE, NABIDAE and LYGAEIDAE taken were mostly females, the CAPSIDAE were predominantly males, almost all the females of the CAPSIDAE taken being those belonging to species of which many specimens occurred in the trap. Of some Capsids there were very few or no females, e.g. *Orthotylus flavosparsus* Sahlb., *Plesiocoris rugicollis* Fall., *Megalocoleus molliculus* Fall., and *Asciodema obsoletum* Fieb. There does not appear to be any obvious explanation for these cases, since all these species have macropterous females fully capable of sustained flight. The occurrence of females in the CORIXIDAE is less puzzling, and almost certainly represents a tendency in pregnant females to wander from overcrowded ponds.

It was unfortunate that for the majority of the species there were too few specimens taken for any significant results to be obtained from the interesting method of analysis of time of flight shown in Fig. 1.* In the seven species figured it is possible to see totally different and unexpected types of activity. In *Adelphocoris lineolatus* Goeze there is a maximum of activity between midnight and sunrise, with a sub-maximum a few hours after sunset. In the closely related *Lygus pratensis* L. there is an entirely different type, having its maximum at sunset, its minimum shortly before sunrise and a sub-maximum at sunrise. *Orthops kalmi* L. (formerly placed in the genus *Lygus*) gives similar results to the last species, but has its minimum at midnight. *Megalocoleus molliculus* Fall. (a light green species) has a marked period of activity at sunrise. Its minimum seemed to be in the first half of the night. Similarly *Orthotylus flavosparsus* Sahlb., another light green species, is also active just before sunrise, and hardly at all at other times during the night.

Stenotus binotatus F. and *Asciodema obsoletum* Fieb. both belong to a type showing more or less uniform activity towards light during the night.

The various habitats of the species attracted to light can be placed under three heads, *i.e.* aquatic, arboreal and terrestrial (*i.e.* those living close to the ground). The following table gives the numbers of species and individuals taken in the trap which can be referred with certainty to these habitats.

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* The analysis is made on the number of nights on which the species appeared in any particular bottle, and not on the number of individuals per bottle.

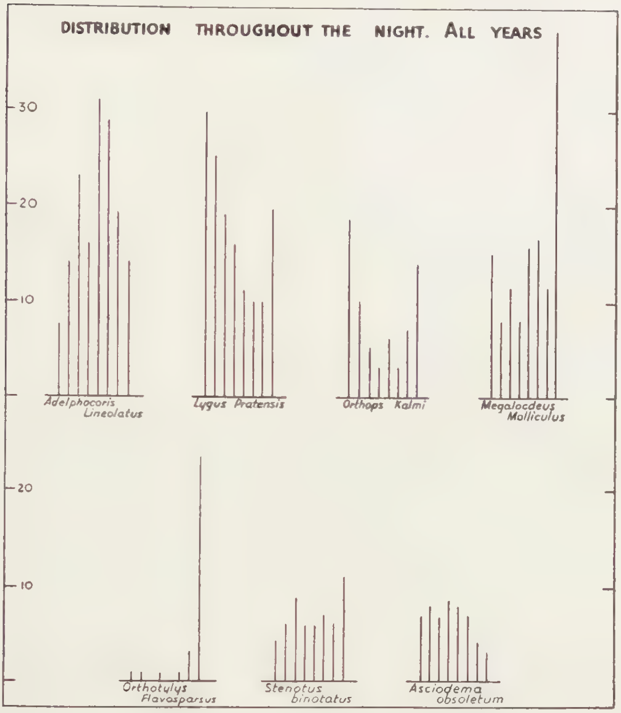

TABLE IV.

Family Habits of Species from Trap.

	Arboreal		Ground living		Aquatic	
	spp.	nos.	spp.	nos.	spp.	nos.
PENTATOMIDAE	1	1	1	1	—	—
LYGAEIDAE. . . .	—	—	2	3	—	—
TINGIDAE	—	—	1	1	—	—
NABIDAE	—	—	3	17	—	—
ANTHOCORIDAE . . .	2	7	—	—	—	—
CAPSIDAE	38	388	19	1026	—	—
CORIXIDAE	—	—	—	—	6	42

The arboreal species can be further divided into groups of species from the various host trees (all of which can be found within half a mile of the trap), as follows.

TABLE V.

Distribution of Arboreal Species in Trap According to Host Plant.

Host plant :	Oak	Hazel	Pine	Wych Elm	Apple	Lime	Gorse	Broom	Ash	Aspen
No. of species .	11	5	5	3	3	2	2	2	1	1
No. of individuals	81	18	20	18	42	8	181	12	2	7

TABLE VI.

Annual Occurrence of CAPSIDAE.

Occurrence in trap No. of years :	4	3	2	1	Total
No. of spp.	10	6	12	29	57
Average no. per species . .	106	34	7	2·5	25
% of known British spp. . .	5·6	3·4	6·8	16·3	31·5
% of known Herts. spp. . .	8·3	5	10	20·8	47·5

In Table VI the numbers of the species of CAPSIDAE in the trap are compared with the British list and with the Hertfordshire list of CAPSIDAE. The last list was compiled from Butler's lists (1923) and those of other authors as well as from extensive personal collection for five years in the county. It is seen that few species occurred in all four years, and that the majority only occurred in one year. Moreover the more regularly a species occurred from year to year the more individuals of that species were taken, and in the species which only came in one year very many less individuals were taken.

During the four years some interesting additions to the list of Heteroptera of the south of England were made : *Elatophilus nigricornis* Zett. and *Plesiodema pinetellum* Zett., which previously had not been recorded in this country south of Perth and Northumberland respectively.

It is curious to note that both species are found exclusively on *Pinus sylvestris* in Britain.

A remarkable catch of *Asciodema obsoletum* Fieb. occurred throughout the night of July 1st, 1934, when 77 males were taken. The total of this species for 1934 was 114 males and for all years 158 males. This species is an inhabitant of gorse, of which plant there is a large quantity on Harpenden Common, a quarter of a mile from the trap.

STUDIES ON THE DISTRIBUTION OF NITROGEN IN INSECTS. I. IN THE CASTES OF THE WASP, *VESPULA GERMANICA* (FAB.)

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Introduction.

Very little work has been done on the distribution of nitrogen in insects, although a body of data exists on the total nitrogen content, Uvarov (1928). While a knowledge of the total nitrogen content of an insect is useful for certain purposes, a knowledge of the relative or absolute amounts of nitrogen in the various nitrogenous substances present in the insect would probably be of far greater value. Thus in comparing the nitrogen metabolism or content of a prepupa with its pupa and adult, a fractionation of the total nitrogen content would probably yield far more interesting information than the total nitrogen content itself would.

It is the purpose of this and the following studies to examine the distribution of nitrogen in various insects in order to provide data on which an adequate method of analysis may be based, and also to formulate problems worthy of further study.

A number of studies have been made of the fluctuations of certain nitrogen fractions in insects. Courtois (1930) showed that there are big fluctuations in non-protein nitrogen during metamorphosis and also big differences between species. Florkin (1935) examined the % protein in blood and found that, in general, it seemed to increase from immaturity to maturity. Uvarov (1929) gives several other examples. Little work has been done on the fractionation of the total nitrogen content. Haydak (1934) followed the increase in nitrogen in the head, thorax, abdomen and alimentary canal of worker bees after emergence. He found a definite increase in the nitrogen content on these parts of the body with increasing age, the increase in the head and thorax being associated with the development of the pharyngeal glands as the bees prepare to assume the nurse phase of their activities. Evans, (1932) and (1934), has studied the fluctuations during metamorphosis of the following nitrogen fractions in *Lucilia sericata* Mg., and *Tenebrio molitor* L., skeletal N (incorrectly termed chitin N), protein N insoluble in distilled water, protein N soluble in distilled water, proteose and peptone N, amino-acid N, and excretory N.

Methods of Analysis.

Ten weighed individuals were ground in a mortar in distilled water with a little washed ignited sand for 10 minutes and allowed to stand for another 10 minutes. The soluble nitrogen was filtered off on a large Buchner funnel and the insoluble residues were washed several times with small amounts of distilled water so that the total filtrate was ultimately made up to 45 ml.; 5

ml. of 12·5% trichloracetic acid was added to the filtrate to precipitate the proteins which were filtered off, proteoses and peptones in the filtrate were precipitated by adding 7 ml. of 10% sodium tungstate and 7 ml. of 0·66 *N*-sulphuric acid. The nitrogen present in the tungstic acid filtrate is termed rest N. To effect a separation of the skeleton from the insoluble protein, the water-extracted residues were hydrolysed in 1% potassium hydroxide for 4 hours and the skeleton was filtered off and thoroughly washed with distilled water, Buxton (1932). This method gave good duplicate results, but when the skeletal N content of just-emerged queens (2-3 hours old) was compared with that of queens with their fat-bodies fully developed in preparation for hibernation (called hibernating queens for convenience), it was found that the latter contained very much more than the former. It was expected that some difference would be found, as just-emerged queens have a much softer exoskeleton than hibernating queens. A further examination of this question confirmed the large difference found, and also revealed, further, that a considerable amount of the skeletal N of this insect is soluble in 1% potassium hydroxide. It is therefore necessary to correct the skeletal N content found by hydrolysing the water-extracted residues in 1% potassium hydroxide. The correction factors found were × 3·03 for old adults and × 3·22 for just-emerged adults. The full results of this work on the determination of skeletal N will be published elsewhere.

Duplicate estimations were made in every case except that of the laying queen. The duplicate estimations agreed very well and were usually within 5% of the mean. In the two *Vespula* nests taken in September and October for this work, one laying queen was found in the first nest taken, but in the second case the laying queen was not found. Thus the results reported depend only on the analysis of one individual, and due consideration must be paid to this in examining the results. Just-emerged workers and old workers were analysed within 36 hours of emergence, analyses could not be performed earlier owing to pressure of time. Workers actively engaged in the economy of the nest when it was taken are considered as old workers, and are of mixed ages, but definitely older than the just-emerged workers. It was not possible to distinguish with certainty the worker and drone prepupae in the nest taken in October; it contained both the immature and adult sexual forms. Most of the emerged drones were much larger than the workers, but those just emerging were of the same size as the worker, and they were emerging from the same sized cells as the workers.

RESULTS.

Table I shows that there is a great variation in the percentage total N contents of the different castes at different stages of their development. The old workers have the highest percentage total N, followed by the laying queen, just-emerged and hibernating queens, just-emerged workers, drones and prepupae.

Although there is a big difference in the percentage total N contents of old and young workers, no difference is found in the absolute amounts of nitrogen found in each, *i.e.* 2·96 and 2·97 mgs. per individual. The big increase in percentage total N content is due to a decrease in weight—about 25%—which the workers undergo after emergence. Haydak (1934) found that the workers of the honey-bee increase in weight and also in absolute and percentage content of nitrogen after emergence.

TABLE I.

Percentage nitrogen in the three castes at various times of development (expressed on a wet weight basis).

	Laying queen	Hibernating queen	Just-emerged queen	Just-emerged worker	Old worker	Drone	Queen prepupa	Worker prepupa
Wet weight per individual in mgs.	358	281	260	102	76	137	429	178
Total	3·60	3·08	3·07	2·91	3·89	2·66	2·20	2·12
Skeletal N	1·02	1·60	1·12	0·85	1·30	1·13	0·03	0·02
Insoluble Protein N	0·59	0·41	0·57	0·75	0·84	0·63	0·42	0·31
Soluble Protein N	1·53	0·83	0·80	0·78	1·25	0·63	1·43	1·35
Proteose N	0·26	0·12	0·36	0·23	0·25	0·13	0·19	0·25
Rest N	0·20	0·12	0·22	0·30	0·25	0·14	0·13	0·19

The largest amounts of nitrogen in the adults are found in the skeleton and soluble protein fraction. In the prepupae, however, only a very small amount of skeletal nitrogen is present, by far the greatest amount of it being found in the soluble protein fraction. The prepupae contain far more soluble protein N on a basis of total nitrogen content than any of the other forms examined. There are no significant differences in the distribution of nitrogen in the prepupae of queens and workers, Table II.

TABLE II.

Percentage distribution of nitrogen on a basis of the total nitrogen content.

	Laying queen	Hibernating queen	Just-emerged queen	Just-emerged worker	Old worker	Drone	Queen prepupa	Worker prepupa
Skeletal N.	28·1	52·5	36·7	29·4	33·5	42·6	1·2	1·1
Insoluble Protein N.	16·8	13·3	18·4	25·6	21·6	23·6	19·0	14·9
Soluble Protein N	42·4	27·4	26·2	26·9	32·1	23·6	64·9	63·2
Proteose N	5·6	3·9	11·7	7·7	6·4	5·0	8·9	11·9
Rest N	7·1	3·9	7·0	10·4	6·4	5·2	6·0	8·9

The laying queen has nearly half of her percentage total N content in the form of soluble protein N; this perhaps is present chiefly in the developing eggs, *vide infra*. The other adults examined contain about equal amounts of soluble protein N. The insoluble protein N presents some variation; this fraction includes the nitrogenous substances of the tissues and reserve protein or proteins insoluble in distilled water. Improved methods of extraction are required to separate these. That reserve protein insoluble in water is present in small amounts is strongly suggested by the following considerations. Just-emerged queens and workers contain more insoluble protein N and proteose N but less skeletal N than hibernating queens and old workers. It would therefore appear that this protein, insoluble in distilled water, is utilised soon after emergence to complete the hardening of the skeleton. A similar relationship between a water-insoluble protein and the hardening of the puparium of *Lucilia sericata* was found by Evans (1932).

The percentage total N contents of just-emerged and hibernating queens are very similar, but as the latter are about 8% heavier than the former, the absolute amount of nitrogen has increased by about 8% or 0·7 mgs. per individual. This amount, however, does not represent the total amount of nitrogen gained from food during the time the fat-body is developing. The just-emerged queen has more rest N than the hibernating queen: most of this is probably uric acid, and so is excreted. The difference in the rest N contents should therefore be added to the above figure, giving a total of about 1·0 mg. of nitrogen increase. An estimation of the nitrogen present in the fat-body of hibernating queens was made by slitting open an abdomen laterally, pinning it on to a wax dissecting-dish, removing the alimentary canal and mass of malpighian tubules under a binocular microscope and then washing the fat-body on to a Buchner funnel with a jet of 2·5% trichloracetic acid from a wash-bottle. The main part of the fat body lies between the dorsal and ventral diaphragms and is removed completely with ease, that portion lying between the diaphragms and the body-walls was teased with needles and washed on to the funnel; very little fat-body was left and the muscles remained practically in their entirety. The percentage fat-body N on a basis of the body-weight of the queen was estimated in triplicate, and gave the following results: 0·28%, 0·30% and 0·30%. Since the hibernating queen contains about 25% of its nitrogen in the form of soluble protein, a much higher content of nitrogen was expected in the fat-body than the 10% (on a total N basis) found. The actual weight of the fat-body of the hibernating queens was determined by dissecting out the fat-body and weighing it, taking care to do the dissection as rapidly as possible to prevent evaporation of water, the dissected material being kept in a lightly corked vial while dissection was proceeding. The results are considered to be correct to within 5–10% of the true percentage weight. Triplicate estimations gave the following results on a basis of the body-weight of the queen: 25·3%, 25·5% and 24·2%. If the above results are used in conjunction with the nitrogen content of the fat-body, the latter will have a percentage N content of about 1·3. The amount of nitrogen, on a basis of body-weight, in the fat-body of drones, was found to be 0·19%, 0·13% and 0·12%—about half that of the hibernating queens. The amount of fat-body in the drone was so small that no attempt was made to estimate its weight. A similarly small amount of fat-body is present in the just-emerging queens. If the nitrogen content of the fat-body of drones and just-emerged queens is approximately similar, it would appear that during the great growth of the fat-body of the queens after emergence very little nitrogenous reserve materials are laid down. Whether any reserve proteins are to be found in the fat-body of the laying queen remains for future investigation. The presence, in the fat-body, of only a small proportion of the total nitrogen present has been noted in a lepidopterous prepupa, Evans (unpublished).

A large amount of fat is probably laid down in the fat-body for use during hibernation, since it was found that when the water-insoluble residues were filtered under reduced pressure after hydrolysis in 1% potassium hydroxide, little trouble with the formation of a soapy foam was experienced in drones and just-emerged queens, but a great deal of soapy foam was produced from hibernating queens. The food of queens after emergence is in all probability principally of a carbohydrate nature, since their alimentary canals contained a clear sweet viscous fluid. This fluid perhaps consists of nectar and the juice of rotting fruit.

SUMMARY.

The distribution of nitrogen in the castes of the wasp at various stages of development is discussed. In the adult most of the nitrogen is present in the skeletal and soluble protein fractions, in prepupae little is found in the skeleton, but over 60% is in the form of soluble protein. Just-emerged wasps probably contain a reserve protein, insoluble in water, which is utilised to complete the hardening of the skeleton. The fat-body of queens preparing for hibernation weighs about 25% of the body-weight and contains about 1·3% of nitrogen. The food of queens preparing for hibernation is probably chiefly of a carbohydrate nature, since a large amount of fat seems to be present in those which have well-developed fat-bodies.

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BOOK NOTICE.

The Historical Development of Insect Classification. By H. F. WILSON and M. H. DONER (Copyright by the authors). 4to. St. Louis, etc., 1937. pp. ii + 133, text illust.

This book is " Planographed," and not printed in the accepted sense of that word. The result resembles a lightly printed type-written page, and is produced at a fraction of the normal printing cost.

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This work is the first published result of an entomological expedition made by R. Frey and R. Storå to the Canary Islands in 1931.

It is divided into four parts: 1, List of Diptera of the Canary Islands; 2, Zoogeographical grouping of Canarian Diptera; 3, the Insular distribution of Diptera of the Canary Islands and Madeira; 4, the distribution by zones of the Diptera of the Canary Islands.

The first part occupies 147 pages of the book, and includes contributions by the specialists named in the title. Two new genera and many new species are described.

Part 2 discusses the zoogeographic groups of Diptera and gives lists of species, and Parts 3 and 4 are devoted to similar treatment of the Insular distribution and the zonal distribution of the Diptera of the islands.

A list of literature cited is given and ten photographic plates complete the book.

Bugs, Birds and Blizzards in the Yellowstone. By H. B. Mills. Collegiate Press, Ames, Iowa. 1937. Pp. vii + 76, 6 pls., 1 map. Price $0.50.

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It is addressed to the field naturalist and lover of Nature in the wild regions of the Park. The photographs are admirably made and form a very attractive feature.

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